

## Communication Links for Offshore Platforms

**A User's Guide to Troposcatter Communications**

## 1.0 INTRODUCTION

Offshore platforms, whether for coastal defense systems, environmental monitoring, pipe line operations, or oil and gas production, represent a significant construction effort and investment. Telecommunication links between an offshore platform and a shore facility are crucial and essential for platform operations and must be designed and selected carefully. Typically most offshore platforms are in a relatively fixed location for long periods, and telecommunication links may be planned and implemented in a conventional manner. The information in this document is designed to assist a platform owner or operator in choosing and specifying a communication link for an offshore platform.

### 1.1 Platform Types

There are many platform types used depending on the application, the distance offshore, and the environment. The type of platform has a major effect on the communication link design. A summary of most of the major platform types are listed in Table 1.

**Table 1. Platform Characteristics**

<b>Offshore Platform Type</b>	<b>Locations Used</b>	<b>Movement and Stability</b>	<b>Communication Link Choices</b>
Fixed leg platform	Shallow water, typically close to shore	Very stable	Any type of communications link can be employed.
Tower	Deeper water than fixed leg	Stable in vertical direction, limited movement in horizontal direction.	Any type of communications link can be employed.
Spar	Deeper water than fixed leg	Stable in vertical direction, limited movement in horizontal direction.	Any type of communications link can be employed.
Tension Leg Platform	Deeper water than fixed leg	Stable in vertical direction, limited movement in horizontal direction.	Any type of communications link can be employed.
Semisubmersible	Tends to be very deep water and longer distances offshore	Generally stable in all directions, depending on mooring system.	Could required autostabilized antenna system. Very limited movement, typically less than 10 degrees
Floating Production System (FPS)	Tends to be very deep water and longer distances offshore	FPS movement depends on mooring system. A turret moored system will weather vane around the bow. An FPS with four or more mooring points will be relatively stable	A turret moored FPS is limited for point to point radio links due to 360 degree movement around the bow. An FPS with fore and aft movement is relatively more stable, but will most likely require an autostabilized antenna due to roll, pitch and yaw of the FPS.

## 1.2 Platform Location

The platform location has a major effect on communication link planning as summarized below.

Shallow water: fixed leg and tower, relatively stable platform, carry a large work force population, usually close to shore, require high capacity communications to onshore networks, auto stabilization is typically not required because the platforms are fixed.



**Figure 1. Fixed Leg Platform**



**Figure 2. Gravity Base Fixed Platform**

Shallow water applications may employ radio networks to neighboring platforms using a hub design with one platform serving as the main connection to a shore site. Generally shallow water applications can employ either microwave or troposcatter links depending on the distance offshore.

Deep and ultra deep water: spars, tension leg, semi submersibles, FPSO's and similar, greater distance off shore, smaller work forces, more costly to establish communications to onshore networks, communications outages have a larger penalty due to distance offshore, and communication links are more critical for platform operations. Requires autostabilized antennas.



**Figure 3. FPSO**

### 1.3 Communication Links Considerations

There is an increasing number of offshore platforms, in shallow water close to shore and at extended distances, 100 Km to 300 Km offshore in very deep water. The current trend is farther offshore in deeper water. Regardless of the type of communication link employed (point to point radio, VSAT, or fiber) some basic requirements apply to all communication links. These must be considered in relation to the platform type and the communication media used (radio or fiber).

- **Cost:** Both the one time equipment and commissioning cost must be considered, but more important is the recurring operating costs. The recurring operating cost will often exceed the one time capital costs. See section 2 on this topic.
- **Capacity:** Capacity is usually directly related to cost, both for recurring and one time capital costs. See section 2 on this topic.
- **Reliability:** Usually the operation of an entire production platform depends on a functioning communications link to a shore site. Therefore the link reliability is critical for maintaining the availability of the platform. When considering communications link reliability be sure to separate the equipment reliability from the transmission reliability. This has a major effect on equipment design and selection.
- **Back-up:** Back-up equipment is considered essential by most operators due to the financial and safety penalty incurred if the equipment fails, and the cost and time to obtain spares and repair the problem.
- **Physical Facilities:** The physical facilities are different for each type of communication link used and can be a factor in equipment selection. The usual factors are power, backup power, floor space, deck space, environmental conditioning, hazardous areas where equipment cannot be installed.
- **User Services:** User requirements for capacity (band width) increase year over year as more services become available for offshore use. Also to be considered is the type of services needed and if IP enabled or if a conventional TDM service. The specific types and implementation of voice, video, and data, have a major effect on choosing a communications link.
- **Remote Access:** Remote access is important for monitoring and controlling the communications equipment on the offshore platform from a centralized network operations center (NOC).
- **Offshore Networks:** With the increasing number of offshore platforms, there is a much wider use of offshore networks between platforms, and one or more hub platforms for the link to a shore site.

## 2.0 COMMUNICATION LINK COMPARISON

### 2.1 Advantages and Disadvantages

There are many things to consider when comparing communication links for offshore platforms. To begin, consider the known advantages and disadvantages of different types of communication links for offshore as shown below in Table 2.

**Table 2. Advantages and Disadvantages of Transmission Systems for Offshore**

Transmission Media	Main Advantage	Main Disadvantage
Microwave line of sight	Low cost equipment, high capacity, high reliability	Requires line of sight, limiting distances to approximately 30 Km
Troposcatter	High capacity, no delay, IP based system, no recurring monthly costs	Equipment cost is higher than microwave and VSAT, but lower than undersea fiber
VSAT	Equipment cost is low, is most economical for low capacity (512 Kb/s or less)	Delay (latency), availability degradation (outages), monthly transponder lease cost
Undersea fiber	Highest capacity, can serve many platforms in an entire oil field or basin	Installation cost is very high, estimated more than US\$10 million per 100 Km

### 2.2 Cost and Capacity

There is an increased demand for bandwidth for offshore, oil and gas production platforms, especially when one platform is a hub and provides radio links to remote platforms in the vicinity of the hub platform. The increased demand for capacity is not just because of the number of platforms but due to the need for more services for voice, data, SCADA equipment, video surveillance, Internet and corporate LAN access, and channels to collocated radio networks such as ground to air and marine. Typically most oil and gas operators are looking for in excess of 16 Mb/s for offshore links, to replace low rate (1 Mb/s), legacy VSAT links. High capacity microwave is usually specified if the platform is within 30 Km from the shore, and troposcatter for longer distances.

### 2.3 Recurring Costs

The considerations in comparing equipment costs and capacity is one time capital costs for equipment, and recurring costs for services. Generally the radio cost for microwave and troposcatter radios does not change as the capacity is changed. This is a big advantage of microwave and troposcatter over VSAT. The cost for microwave and troposcatter is relatively insensitive to capacity. There is no penalty for using the highest available capacity. Whereas with VSAT systems, operators tend to use the lowest possible capacity due to high recurring costs for the space segment. Undersea fiber is the most expensive and generally used only when very high capacity is required.

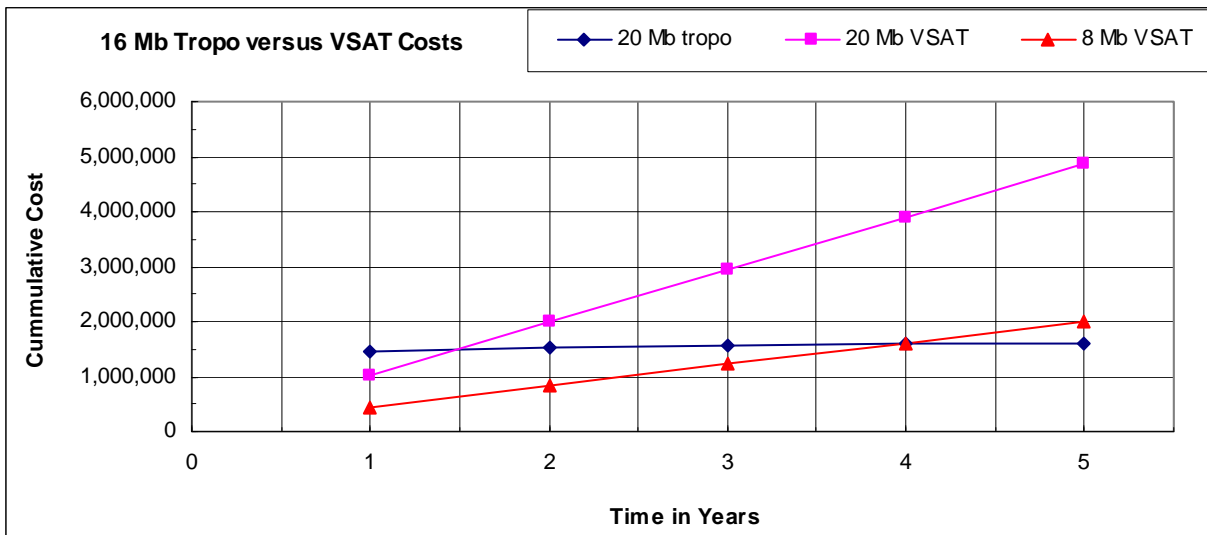
An approximate comparison between microwave radio, troposcatter, VSAT, and undersea fiber based on cost and capacity is shown below in Table 3.

**Table 3. Cost and Capacity Comparison**

Transmission Media	Equipment Cost	Recurring Cost	Capacity
Microwave radio, line of sight	low	None	high
Troposcatter	medium	None	medium
VSAT	low	Monthly lease depends on capacity	low
Undersea fiber	high	Generally monthly recurring cost for standby restoral services in case of cable break.	very high

Figure 4 shows the following:

- Compares troposcatter and VSAT over time, from year 1 to year 5
- Highlights the difference between fixed equipment costs (troposcatter) and recurring costs (VSAT)
- Shows that the recurring costs of VSAT exceed the equipment costs of troposcatter after about 1 ½ years for 20 Mb/s circuits over satellite



**Figure 4. Cost versus Time for VSAT and Troposcatter**

## 2.4 Distance

Distance is a major factor in choosing a communication link. Offshore platforms that are beyond line of sight (generally more than 30 km offshore) can use troposcatter radio links, VSAT links, or undersea fiber optic cable. Other types of transmission systems such as HF, VHF, UHF, microwave at any frequency, or free space optics are not suitable because of distance (the offshore platform is beyond the horizon). A summary of distance related factors is in Table 4.

**Table 4. Distance Comparison**

<b>Transmission Media</b>	<b>Distance</b>	<b>Characteristic</b>	<b>Capacity</b>
Microwave radio, line of sight	Short, up to approximately 30 Km	Cost is relatively insensitive to distance, small cost increase for antennas and towers as distance increases	High, OC-1, 52 Mb/s or higher
Troposcatter	From line of sight (30 Km) up to approximately 250 Km	Small increase in cost with distance due to larger antennas and power as distance increases	Medium, 20 Mb/s
VSAT	Anywhere in a satellite transponder footprint	Insensitive to distance	Low 256 Kb/s typically up to 4 Mb/s, limited by transponder lease cost
Undersea fiber	Distance is typically not a limiting factor.	Acquisition cost is proportional to distance, relatively insensitive to capacity, recurring cost for standby restoral service for cable breaks	Highest capacity, multiple STM-1, 155 Mb/s

## 2.5 Technical

There are several technical considerations in comparing different communication links for an offshore oil and gas production platform.

- **Latency:** The transmission through a troposcatter link is virtually instantaneous compared to satellite transmission, 250 msec end-to-end delay and 500 msec round trip delay. VSAT transmission delay seriously reduces TCP/IP channel throughput and performance due to the error checking and acknowledgements required. Latency is a problem with circuits that are two way interactive and require a fast response for error checking, acknowledgement, or programmed operation. Some oil and gas representatives state that they avoid using VSAT links due to the latency problem.
- **Outages:** Troposcatter links generally have a higher availability than VSAT links. Availability on VSAT links suffers from satellite operator caused outages, outages due to problems or interference in the satellite, and housekeeping tasks from the satellite operator. None of these problems occur with a troposcatter link.

- **Performance:** Due to limited RF power on the satellite down link channel, most VSAT links operate with a low carrier to noise ratio and have a very low margin for an acceptable error rate. Therefore any changes in the transmission path such as from rain or movement of the antenna can easily cause degraded performance.
- **Communications from shore station to a few offshore platforms:** The choice for this is most likely between VSAT and troposcatter. Undersea fiber would be too expensive for this scenario. The choice between VSAT and troposcatter would be based on costs and delay. For low capacity 1 Mb/s or less, VSAT is typically less costly. For capacities of 4 Mb/s or greater troposcatter is less costly after approximately 3 years.
- **Communications across an entire oil field to many platforms:** The choice for this scenario is either troposcatter or undersea fiber, with interconnecting, offshore radio links between platforms, depending on the area and number of platforms. The main determining factor is the overall capacity from the shore to all the offshore platforms. Troposcatter can provide up to 20 Mb/s on a single link and fiber can provide many times more.
- **Power:** Most offshore platforms for oil and gas have multi-megawatt power generation equipment, in dual and triple redundancy. The amount of power consumed for a communications terminal, VSAT, microwave or tropo, is a very small amount compared to the platform overall consumption. Power reliability on offshore platforms is typically designed for high availability due to the production processes and safety, so that power for a communications terminal is typically more reliable than on a shore site.

### **3.0 TROPOSCATTER SYSTEMS FOR OFFSHORE PLATFORMS**

#### **3.1 Troposcatter Advantages**

The minimum operating costs, high capacity, and unique technical features of troposcatter links provides an advantage over other communication systems for offshore platforms greater than about 30 Km offshore. A summary of the advantages of troposcatter links are listed below.

- **Latency:** transmission via troposcatter is virtually instantaneous, VSAT round trip delay, 500 msec, reduces throughput and performance
- **Outages:** VSAT outages controlled by satellite operator, troposcatter links are controlled by the platform operator
- **Availability:** troposcatter generally higher availability than other radio systems
- **Troposcatter less costly over long term**

#### **3.2 Troposcatter Characteristics**

The general characteristics of troposcatter links used for offshore platforms are listed below. These characteristics are what make troposcatter links ideally suited for offshore platforms.

- **Capacity:** to 20 Mb/s
- **Availability:** greater than 99.9%
- **Distances:** from line of sight to 250 Km



- Frequency bands: 2 GHz and 5 GHz
- Operation: automated, unattended
- Ownership and control: platform operator

### 3.3 Troposcatter Applications

Troposcatter links have been used successfully for more than 30 years for offshore links, in every possible environment. Troposcatter links are the main choice today for high capacity links that are beyond line of sight from shore (more than 30 km). An example of some troposcatter links implemented by Comtech around the world are shown in Table 5.

**Table 5. Comtech Offshore Troposcatter Link Examples**

Location	Distance	Years	Capacity	Notes
Gabon	265 km	1995	8 Mb/s	One link
UAE, Gulf	100 -140 km	1988 - 1995	8 Mb/s	Multiple links
Mexico	90 km	2002	8 Mb/s	Offshore to offshore
East Malaysia	130 km	1998 - 2003	8 Mb/s	Multiple links
North Sea, 7 GHz	100 Km	1998	8 Mb/s	Offshore to offshore
Peninsula Malaysia	100 -150 Km	1988 - 1992	2 Mb/s	Multiple links
Australia	130 km	1994	2 Mb/s	One link
North Sea Shetlands	300 Km	1978 - 1995	372 channel analog	Offshore to mainland
Scotland, Mormond Hill	200 – 270 Km	1978 to present	72 channel analog and 8 Mb/s digital	Multiple platforms, digital links still in operation
Scotland, Aberdeen	175 Km	1974 – 1988, earliest North Sea troposcatter	60 channel analog	Offshore to mainland
England	100 Km	1980 - 1986	60 channel analog	Low power 2 GHz

An example of some troposcatter equipment installed on offshore platforms are in Figure 5 and Figure 6. These pictures illustrate the items below.

- A large platform can serve as a hub with microwave or troposcatter links to near by platforms and long distance troposcatter link to an onshore network
- Single or dual antennas can be used depending on design and distance
- Front of antennas must be free of any obstructions



**Figure 5. Hub Platform with Multiple Links**



**Figure 6. Platform with Single Antenna**

## 4.0 SUMMARY

Communication links to offshore platforms can be implemented in many ways with microwave, troposcatter, VSAT, and fiber. Each has advantages and disadvantages that depend on the application. When comparing different solutions, the most useful comparison is cost and capacity. Other technical factors, such as IP based traffic, latency, equipment space, can usually be designed into the solution to meet the requirements. A summary of the advantages and disadvantages of each type communication link is below in Table 6.

**Table 6. Communication Link Summary**

Type	Primary Advantage	Primary Disadvantage	Primary Choice
Microwave Radio	High capacity, low cost equipment	Limited to line of sight links	Shallow water platforms within approximately 30 Km from a shore station
Troposcatter Radio	High capacity, can reach long distances offshore	Equipment cost compared to microwave and VSAT	Any offshore platform from 30 Km to approximately 250 Km
VSAT	Global reach	Recurring transponder lease costs	Low rate, less than 2 Mb/s, connectivity between offshore and onshore sites geographically remote from the oil field.
Optical fiber	Highest capacity	Installation costs, recurring costs for standby restoral services	Used for large fields such as the North Sea and the Gulf of Mexico for implementing a large network of multiple platforms.